

Dominant Presence of Oxygenated Organic Species in the Remote Southern Pacific Troposphere

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Oxygenated organic species are intimately involved with the fate of nitrogen oxides (NO_x) and hydrogen oxides (HO_x), which are necessary for tropospheric ozone formation. A recent airborne experiment (March-April, 1999) focused over the Southern Hemisphere (SH) Pacific Ocean (Pacific Exploratory Mission-Tropics B (PEM-Tropics B)) provided a first opportunity for a detailed characterization of the oxygenated organic composition of the remote Southern Hemisphere troposphere. Three co-located multichannel airborne instruments measured a dozen key oxygenated species (carbonyls, alcohols, organic nitrates, organic peroxides, peroxides) along with a comprehensive suite of C_2 - C_8 nonmethane hydrocarbons (NMHC). Analyses done in FY00 on these measurements reveal that in the tropical SH (0° - 30°S), oxygenated chemical abundances are extremely large and collectively are nearly five times those of NMHC. Even in the northern hemisphere remote atmospheres, their burden is equal to or greater than that of NMHC. Therefore the

global extent of oxygenated chemicals is greater than was previously thought. The relatively uniform global distribution of oxygenates is indicative of the presence of large natural and distributed sources. A global three-dimensional model, reflecting the present state of knowledge, is unable to correctly simulate the atmospheric distribution and variability of several of these species. More research is needed to discover the sources and transport mechanisms associated with these findings before global models can be improved to reflect this new information.

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ER-2 and DC-8 Meteorological Measurement Systems

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The Meteorological Measurement System (MMS) provides high-resolution, airborne meteorological parameters (pressure, temperature, turbulence index, and the three-dimensional (3-D) wind vector). The MMS consists of three major systems: (1) an air-motion sensing system to measure the air velocity with respect to the aircraft, (2) an aircraft-motion sensing system to measure the aircraft velocity with respect to the earth, and (3) a data-acquisition system to sample,

process, and record the measured quantities. Since much of the instrumentation is attached to the aircraft at judiciously chosen locations, the MMS is a platform-specific instrument that cannot be transported from one aircraft to another.

The MMS is uniquely qualified to investigate atmospheric mesoscale (gravity and mountain lee waves) and microscale (turbulence) phenomena. An accurate characterization of the

turbulence phenomenon is important for the understanding of dynamic processes in the atmosphere, such as the behavior of buoyant plumes within cirrus clouds, diffusions of chemical species within wake vortices generated by jet aircraft, and microphysical processes in breaking gravity waves. Accurate temperature and pressure data are needed to evaluate chemical reaction rates and to determine accurate mixing ratios. Accurate wind-field data establish a detailed relationship between the various constituents, and the measured wind also verifies numerical models used to evaluate air-mass origin. Since the MMS provides quality information on atmospheric state variables, MMS data have been extensively used by many investigators to process and interpret the in situ data from various instruments aboard the same aircraft.

In FY00, the MMS instrument for the ER-2 successfully completed the Stratospheric Aerosol and Gas Experiment (SAGE)-III Ozone Loss and Validation Experiment (SOLVE) deployed to Kiruna, Sweden. The

instrument team produced accurate basic atmospheric state variables that contribute to a broad spectrum of research and investigations. The thermodynamic data provided important measurement constraint and validation for the microphysical studies of the polar stratospheric cloud particles, a critical link in the chlorine activation leading to the destruction of ozone. These basic state data also regulated directly and indirectly the heterogeneous chemical reactions. The 3-D wind data not only provided the meteorological coordinate of the polar vortex, the data supplied the precision for the investigation of mesoscale temperature perturbations that result from mountain waves. In addition, the MMS accurate geometric altitude registration using differential global positioning system (GPS) (less than 5 meter) coordinates provided a significant breakthrough in the interpretation and comparison with satellite-derived data.

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Open Path Diode Laser Hygrometer (DLH) Instrument for Tropospheric and Stratospheric Water Vapor Studies

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The diode laser hygrometer (DLH), developed by NASA's Langley and Ames Research Centers, has flown on the NASA DC-8 on several field missions including Subsonic Aircraft: Cloud and Contrail Effects Special Study (SUCCESS), Vortex Ozone Transport Experiment (VOTE), Tropical Ozone Transport Experiment (TOTE), Subsonic Assessment (SASS) Ozone and Nitrogen Oxide Experiment (SONEX), Pacific Exploratory Mission-Tropics A and B (PEM-Tropics A and B), and the recently completed SAGE III Ozone Loss and Validation Experiment (SOLVE) campaign of 1999-2000. The optical layout of this sensor consists of the compact

laser transceiver mounted to a DC-8 window port and a sheet of retro-reflecting "road sign" material applied to the DC-8 engine enclosure that completes the optical path. The advantages of this sensor approach include compactness, simple installation, fast response time (50 millisecond (msec)), no wall or inlet effects, and wide dynamic measurement range (several orders of magnitude).

Using differential absorption detection techniques similar to those described in the literature, gas-phase water ($H_2O(v)$) is sensed along a 28.5 meter (m) external path. For dry conditions (generally altitudes above 6 kilometers (km)), the diode laser wavelength is locked